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CHEMISTRY DATA BOOKLET

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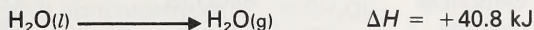
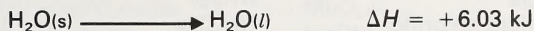
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AMERICAN

BOOKS - 11-1

CHEMISTRY

MISCELLANEOUS



Room temperature = 298 K (25°C)

Standard pressure = 101 kPa

The Avogadro number (N_A) = $6.02 \times 10^{23}/\text{mol}$

Ion product for water (K_w) = $1.00 \times 10^{-14} \text{ mol}^2/\text{L}^2$

Specific heat capacities:

$$\text{H}_2\text{O(s)} = +2.01 \text{ J/(g}^\circ\text{C)}$$

$$\text{H}_2\text{O(l)} = +4.19 \text{ J/(g}^\circ\text{C)}$$

$$\text{H}_2\text{O(g)} = +2.01 \text{ J/(g}^\circ\text{C)}$$

Speed of light (c) = $3.00 \times 10^8 \text{ m/s}$

Charge of 1.00 mol of electrons = $9.65 \times 10^4 \text{ C}$

STANDARD HEATS OF FORMATION

NAME	FORMULA	ΔH_f° (kJ/mol)
aluminum oxide	$\text{Al}_2\text{O}_3(\text{s})$	- 1669.8
ammonia	$\text{NH}_3(\text{g})$	- 46.2
ammonium chloride	$\text{NH}_4\text{Cl}(\text{s})$	- 315.4
ammonium nitrate	$\text{NH}_4\text{NO}_3(\text{s})$	- 365.1
barium carbonate	$\text{BaCO}_3(\text{s})$	- 1218.8
barium chloride	$\text{BaCl}_2(\text{s})$	- 860.1
barium hydroxide	$\text{Ba}(\text{OH})_2(\text{s})$	- 946.4
barium oxide	$\text{BaO}(\text{s})$	- 558.1
barium sulphate	$\text{BaSO}_4(\text{s})$	- 1465.2
benzene	$\text{C}_6\text{H}_6(\text{g})$	+ 82.9
butane	$\text{C}_4\text{H}_{10}(\text{g})$	- 124.7
calcium carbonate	$\text{CaCO}_3(\text{s})$	- 1206.9
calcium chloride	$\text{CaCl}_2(\text{s})$	- 795.0
calcium hydroxide	$\text{Ca}(\text{OH})_2(\text{s})$	- 986.6
calcium oxide	$\text{CaO}(\text{s})$	- 635.5
calcium sulphate	$\text{CaSO}_4(\text{s})$	- 1432.7
carbon dioxide	$\text{CO}_2(\text{g})$	- 393.5
carbon monoxide	$\text{CO}(\text{g})$	- 110.5
chromium(III) oxide	$\text{Cr}_2\text{O}_3(\text{s})$	- 1128.4
copper(I) oxide	$\text{Cu}_2\text{O}(\text{s})$	- 166.7
copper(II) oxide	$\text{CuO}(\text{s})$	- 155.2
copper(II) sulphate	$\text{CuSO}_4(\text{s})$	- 769.9
copper(II) sulphide	$\text{CuS}(\text{s})$	- 48.5
ethane	$\text{C}_2\text{H}_6(\text{g})$	- 84.7
ethanoic acid (acetic acid)	$\text{CH}_3\text{COOH}(\text{l})$	- 487.0
ethanol	$\text{C}_2\text{H}_5\text{OH}(\text{l})$	- 277.6
ethene (ethylene)	$\text{C}_2\text{H}_4(\text{g})$	+ 52.3
ethyne (acetylene)	$\text{C}_2\text{H}_2(\text{g})$	+ 226.7
glucose	$\text{C}_6\text{H}_{12}\text{O}_6(\text{s})$	- 1273.1
hydrogen bromide	$\text{HBr}(\text{g})$	- 36.2
hydrogen chloride	$\text{HCl}(\text{g})$	- 92.3
hydrogen fluoride	$\text{HF}(\text{g})$	- 286.6
hydrogen iodide	$\text{HI}(\text{g})$	+ 25.9
hydrogen peroxide	$\text{H}_2\text{O}_2(\text{l})$	- 187.6
hydrogen sulphide	$\text{H}_2\text{S}(\text{g})$	- 20.1
iron(III) oxide	$\text{Fe}_2\text{O}_3(\text{s})$	- 822.2
iron(II, III) oxide (magnetite)	$\text{Fe}_3\text{O}_4(\text{s})$	- 1117.1
lead(II) bromide	$\text{PbBr}_2(\text{s})$	- 277.0
lead(II) chloride	$\text{PbCl}_2(\text{s})$	- 359.2
lead(II) oxide	$\text{PbO}(\text{s})$	- 217.9
lead(IV) oxide	$\text{PbO}_2(\text{s})$	- 276.6
magnesium carbonate	$\text{MgCO}_3(\text{s})$	- 1112.9
magnesium chloride	$\text{MgCl}_2(\text{s})$	- 641.8
magnesium hydroxide	$\text{Mg}(\text{OH})_2(\text{s})$	- 924.7
magnesium oxide	$\text{MgO}(\text{s})$	- 601.8
magnesium sulphate	$\text{MgSO}_4(\text{s})$	- 1278.2

STANDARD HEATS OF FORMATION (continued)

NAME	FORMULA	ΔH_f° (kJ/mol)
manganese(II) oxide	MnO(s)	-384.9
manganese(IV) oxide	MnO ₂ (s)	-520.9
mercury(II) oxide	HgO(s)	-90.7
mercury(II) sulphide	HgS(s)	-58.2
methanal (formaldehyde)	CH ₂ O(g)	-115.9
methane	CH ₄ (g)	-74.8
methanoic acid (formic acid)	HCOOH(l)	-409.2
methanol	CH ₃ OH(l)	-238.6
nickel(II) oxide	NiO(s)	-244.3
nitric acid	HNO ₃ (l)	-173.2
nitrogen dioxide	NO ₂ (g)	+33.8
nitrogen monoxide	NO(g)	+90.4
octane	C ₈ H ₁₈ (l)	-208.4
pentane	C ₅ H ₁₂ (l)	-146.4
phosphorus pentachloride	PCl ₅ (g)	-398.9
phosphorus trichloride	PCl ₃ (g)	-306.4
potassium bromide	KBr(s)	-392.2
potassium chlorate	KClO ₃ (s)	-391.2
potassium chloride	KCl(s)	-435.9
potassium hydroxide	KOH(s)	-425.8
propane	C ₃ H ₈ (g)	-103.8
silicon dioxide	SiO ₂ (s)	-859.4
silver bromide	AgBr(s)	-99.5
silver chloride	AgCl(s)	-127.0
silver iodide	AgI(s)	-62.4
sodium bromide	NaBr(s)	-359.9
sodium chloride	NaCl(s)	-411.0
sodium hydroxide	NaOH(s)	-426.7
sodium iodide	NaI(s)	-288.0
sucrose	C ₁₂ H ₂₂ O ₁₁ (s)	-2225.6
sulphur dioxide	SO ₂ (g)	-296.9
sulphuric acid	H ₂ SO ₄ (l)	-811.3
sulphur trioxide	SO ₃ (g)	-395.2
tin(II) chloride	SnCl ₂ (s)	-349.8
tin(IV) chloride	SnCl ₄ (l)	-545.2
tin(II) oxide	SnO(s)	-286.2
tin(IV) oxide	SnO ₂ (s)	-580.7
water (liquid)	H ₂ O(l)	-285.9
water (vapor)	H ₂ O(g)	-241.8
zinc oxide	ZnO(s)	-348.0
zinc sulphide	ZnS(s)	-202.9

NOTES: 1. All heats of formation are measured at 298 K (25°C) and 101 kPa.

2. Molar heats of formation for elements in their naturally occurring form are assumed to be zero.

ACID-BASE INDICATORS AT 298 K (25°C)

INDICATOR	pH RANGE	COLOR CHANGE AS pH INCREASES
methyl violet	0.0 - 1.6	yellow to blue
thymol blue	1.2 - 2.8	red to yellow
thymol blue	8.0 - 9.6	yellow to blue
orange IV	1.4 - 2.8	red to yellow
methyl orange	3.2 - 4.4	red to yellow
bromocresol green	3.8 - 5.4	yellow to blue
methyl red	4.8 - 6.0	red to yellow
chlorophenol red	5.2 - 6.8	yellow to red
bromothymol blue	6.0 - 7.6	yellow to blue
phenol red	6.6 - 8.0	yellow to red
phenolphthalein	8.2 - 10.0	colorless to pink
thymolphthalein	9.4 - 10.6	colorless to blue
alizarin yellow R	10.1 - 12.0	yellow to red
indigo carmine	11.4 - 13.0	blue to yellow
1, 3, 5-trinitrobenzene	12.0 - 14.0	colorless to orange

RELATIVE STRENGTHS OF ACIDS AND BASES

% REACTION WITH WATER	ACID		CONJUGATE BASE	K_a
	NAME	FORMULA		
100	perchloric acid	$\text{HClO}_4(\text{aq})$	$\text{ClO}_4^-(\text{aq})$	very large
100	hydroiodic acid	$\text{HI}(\text{aq})$	$\text{I}^-(\text{aq})$	very large
100	hydrobromic acid	$\text{HBr}(\text{aq})$	$\text{Br}^-(\text{aq})$	very large
100	hydrochloric acid	$\text{HCl}(\text{aq})$	$\text{Cl}^-(\text{aq})$	very large
100	nitric acid	$\text{HNO}_3(\text{aq})$	$\text{NO}_3^-(\text{aq})$	large
100	sulphuric acid	$\text{H}_2\text{SO}_4(\text{aq})$	$\text{HSO}_4^-(\text{aq})$	large
100	hydronium ion	$\text{H}_3\text{O}^+(\text{aq})$	$\text{H}_2\text{O}(\text{l})$	—
53	oxalic acid	$\text{HOOC}\text{COOH}(\text{aq})$	$\text{HOOC}\text{COO}^-(\text{aq})$	5.9×10^{-2}
32	*sulphurous acid($\text{SO}_2 + \text{H}_2\text{O}$)	$\text{H}_2\text{SO}_3(\text{aq})$	$\text{HSO}_3^-(\text{aq})$	1.5×10^{-2}
29	hydrogen sulphate ion	$\text{HSO}_4^-(\text{aq})$	$\text{SO}_4^{2-}(\text{aq})$	1.2×10^{-2}
24	phosphoric acid	$\text{H}_3\text{PO}_4(\text{aq})$	$\text{H}_2\text{PO}_4^-(\text{aq})$	7.5×10^{-3}
6.8	**nitrous acid	$\text{HNO}_2(\text{aq})$	$\text{NO}_2^-(\text{aq})$	4.6×10^{-4}
5.9	hydrofluoric acid	$\text{HF}(\text{aq})$	$\text{F}^-(\text{aq})$	3.5×10^{-4}
4.2	methanoic acid	$\text{HCOOH}(\text{aq})$	$\text{HCOO}^-(\text{aq})$	1.8×10^{-4}
—	methyl orange	$\text{HMo}(\text{aq})$	$\text{Mo}^-(\text{aq})$	$\sim 10^{-4}$
2.5	benzoic acid	$\text{C}_6\text{H}_5\text{COOH}(\text{aq})$	$\text{C}_6\text{H}_5\text{COO}^-(\text{aq})$	6.5×10^{-5}
2.5	hydrogen oxalate ion	$\text{HOOC}\text{COO}^-(\text{aq})$	$\text{OOC}\text{COO}^{2-}(\text{aq})$	6.4×10^{-5}
1.3	ethanoic (acetic) acid	$\text{CH}_3\text{COOH}(\text{aq})$	$\text{CH}_3\text{COO}^-(\text{aq})$	1.8×10^{-5}
0.21	carbonic acid($\text{CO}_2 + \text{H}_2\text{O}$)	$\text{H}_2\text{CO}_3(\text{aq})$	$\text{HCO}_3^-(\text{aq})$	4.3×10^{-7}
—	bromothymol blue	$\text{HBb}(\text{aq})$	$\text{Bb}^-(\text{aq})$	$\sim 10^{-7}$
0.10	*hydrogen sulphite ion	$\text{HSO}_3^-(\text{aq})$	$\text{SO}_3^{2-}(\text{aq})$	1.0×10^{-7}
9.5×10^{-2}	hydrosulphuric acid	$\text{H}_2\text{S}(\text{aq})$	$\text{HS}^-(\text{aq})$	9.1×10^{-8}
7.9×10^{-2}	dihydrogen phosphate ion	$\text{H}_2\text{PO}_4^-(\text{aq})$	$\text{HPO}_4^{2-}(\text{aq})$	6.2×10^{-8}
5.4×10^{-2}	*hypochlorous acid	$\text{HOCl}(\text{aq})$	$\text{OCl}^-(\text{aq})$	3.0×10^{-8}
—	phenolphthalein	$\text{HPh}(\text{aq})$	$\text{Ph}^-(\text{aq})$	$\sim 10^{-9}$
8.5×10^{-3}	boric acid	$\text{H}_3\text{BO}_3(\text{aq})$	$\text{H}_2\text{BO}_3^-(\text{aq})$	7.3×10^{-10}
7.5×10^{-3}	ammonium ion	$\text{NH}_4^+(\text{aq})$	$\text{NH}_3(\text{aq})$	5.6×10^{-10}
7.0×10^{-3}	hydrocyanic acid	$\text{HCN}(\text{aq})$	$\text{CN}^-(\text{aq})$	4.9×10^{-10}
2.4×10^{-3}	hydrogen carbonate ion	$\text{HCO}_3^-(\text{aq})$	$\text{CO}_3^{2-}(\text{aq})$	5.6×10^{-11}
3.3×10^{-4}	hydrogen sulphide ion	$\text{HS}^-(\text{aq})$	$\text{S}^{2-}(\text{aq})$	1.1×10^{-12}
1.5×10^{-4}	*hydrogen phosphate ion	$\text{HPO}_4^{2-}(\text{aq})$	$\text{PO}_4^{3-}(\text{aq})$	2.2×10^{-13}
1.8×10^{-7}	water (55.5 mol/L)	$\text{H}_2\text{O}(\text{l})$	$\text{OH}^-(\text{aq})$	1.0×10^{-14}
0	hydroxide ion	$\text{OH}^-(\text{aq})$	$\text{O}^{2-}(\text{aq})$	very small

NOTE: Unless otherwise indicated, all measurements are made at 298 K (25°C) with acid concentrations of 0.10 mol/L (except for indicators, which are not normally used at that high a concentration).

* Temperature = 291 K (18°C)

** Temperature = 285.5 K (12.5°C)

IA	IIA	IIIB	IVB	VB	VIB	VII	VIII	IX	X	XI	XII	IIIB	IVB	VB	VIB	VII	VIII	IX	X	XI	XII	IIIB	IVB	VB	VIB	VII	VIII	IX	X	XI	XII																																																																				
1 H hydrogen 1.01	2 He helium 4.00																																																																																																		
3 Li lithium 6.94	4 Be beryllium 9.01																																																																																																		
11 Na sodium 22.99	12 Mg magnesium 24.31																																																																																																		
19 K potassium 39.10	20 Ca calcium 40.08	21 Sc scandium 44.96	22 Ti titanium 47.88	23 V vanadium 50.94	24 Cr chromium 52.00	25 Mn manganese 54.94	26 Fe iron 55.85	27 Co cobalt 58.93	28 Ni nickel 58.69	29 Cu copper 63.55	30 Zn zinc 65.38	31 Ga gallium 69.72	32 Ge germanium 72.64	33 As arsenic 74.92	34 Se selenium 78.96	35 Br bromine 79.90	36 Kr krypton 83.80	37 Rb rubidium 85.47	38 Sr strontium 87.62	39 Y yttrium 88.91	40 Zr zirconium 91.22	41 Nb niobium 92.91	42 Mo molybdenum 95.94	43 Tc technetium 98.91	44 Ru ruthenium 101.07	45 Rh rhodium 102.91	46 Pd palladium 106.42	47 Ag silver 107.87	48 Cd cadmium 112.41	49 In indium 114.82	50 Sn tin 118.71	51 Sb antimony 121.75	52 Te tellurium 127.60	53 I iodine 126.90	54 Xe xenon 131.29	55 Cs cesium 132.91	56 Ba barium 137.33	57 La lanthanum 138.91	58 Ce cerium 140.12	59 Pr praseodymium 140.91	60 Nd neodymium 144.24	61 Pm promethium (145)	62 Sm samarium 150.35	63 Eu europium 151.96	64 Gd gadolinium 157.25	65 Tb terbium 158.93	66 Dy dysprosium 162.50	67 Ho holmium 164.93	68 Er erbium 167.26	69 Tm thulium 168.93	70 Yb ytterbium 173.04	71 Lu lutetium 174.97	72 Hf hafnium 178.49	73 Ta tantalum 180.95	74 W tungsten 183.85	75 Re rhenium 186.21	76 Os osmium 190.20	77 Ir iridium 192.22	78 Pt platinum 195.09	79 Au gold 196.97	80 Hg mercury 200.59	81 Tl thallium 204.37	82 Pb lead 207.19	83 Bi bismuth 208.98	84 Po polonium (209)	85 At astatine (210)	86 Rn radon (222)	87 Fr francium (223)	88 Ra radium (226)	89 Ac actinium (227)	90 Th thorium 232.04	91 Pa protactinium 231.04	92 U uranium 238.03	93 Np neptunium 237.05	94 Pu plutonium (244)	95 Am americium (243)	96 Cm curium (247)	97 Bk berkelium (247)	98 Cf californium (251)	99 Es einsteinium (254)	100 Fm fermium (257)	101 Md mendelevium (258)	102 No nobelium (259)	103 Lr lawrencium (260)	104 Rf rutherfordium (261)	105 Ha hahnium (262)	106 Ds dubnium (262)	107 Bo bohrium (264)	108 Hs hassium (265)	109 Mt meitnerium (266)	110 Dsb dubnium (268)	111 Rg roentgenium (269)	112 Cn copernicium (284)	113 Nh nihonium (286)	114 Fl flerovium (289)	115 Mc moscovium (288)	116 Lv livermorium (293)	117 Ts tennessine (294)	118 Og oganesson (294)

PERIODIC TABLE OF IONS

GROUP
IA

TABLE OF COMPLEX IONS									
acetate	CH ₃ COO ⁻	perchlorate	ClO ₄ ⁻	oxalate	O ²⁻	hydrogen sulphate	H ₂ SO ₄		
ammonium	NH ₄ ⁺	chlorite	ClO ₂ ⁻	permanganate	MnO ₄ ⁻	bi sulphate	H ₂ SO ₄		
benzoate	C ₆ H ₅ COO ⁻	hypochlorite	ClO ⁻ or OCl ⁻	phosphate	PO ₄ ³⁻	hydrogen sulphite	HSO ₃ ⁻		
borate	BO ₃ ³⁻	chromate	CrO ₄ ²⁻	hydrogen phosphate	HPO ₄ ²⁻	bi sulphite	HSO ₃ ⁻		
		dichromate	Cr ₂ O ₇ ²⁻	hydrogen phosphate	H ₂ PO ₄ ⁻	thiocyanate	SCN ⁻		
		cyanide	CN ⁻			thiosulphate	S ₂ O ₃ ²⁻		
bromate	BrO ₃ ⁻	hydroxide	OH ⁻	silicate	SiO ₃ ²⁻				
carbonate	CO ₃ ²⁻	iodate	IO ₃ ⁻	sulphate	SO ₄ ²⁻				
hydrogen carbonate	HCO ₃ ⁻	nitrate	NO ₃ ⁻	hydrogen sulphide	HS ⁻				
bicarbonate		nitrite	NO ₂ ⁻	bi sulphide					
chlorate	ClO ₃ ⁻								

VIIA VIIIA

TABLE OF COMPLEX IONS											
1	2	3	4	5	6	7	8	9	10	11	12
1	2	3	4	5	6	7	8	9	10	11	12
H ⁺ hydrogen	He helium	Li ⁺ lithium	Be ²⁺ beryllium	B boron	C carbon	N ³⁻ nitride	O ²⁻ oxide	F ⁻ fluoride	Ne neon	Na ⁺ sodium	Mg ²⁺ magnesium
acate ammonium benzoate borate bromate carbonate carbonate bicarbonate chlorate	CH ₃ COO ⁻ NH ₄ ⁺ C ₆ H ₅ COO ⁻ BO ₃ ³⁻ BrO ₃ ⁻ CO ₃ ²⁻ CO ₃ ²⁻ HCO ₃ ⁻ ClO ₃ ⁻	perchlorate chlorite hypochlorite chromate dichromate cyanide hydroxide iodate nitrate nitrite	ClO ₄ ⁻ ClO ₂ ⁻ ClO ⁻ or OCl ⁻ CrO ₄ ²⁻ Cr ₂ O ₇ ²⁻ CN ⁻ OH ⁻ IO ₃ ⁻ NO ₃ ⁻ NO ₂ ⁻	oxalate permanganate phosphate hydrogen phosphate dihydrogen phosphate silicate sulphate sulphite hydrogen sulphide bisulphide	HSO ₄ ⁻ hydrogen sulphite bisulphite thiosulphate HSiO ₃ ⁻ SiO ₃ ²⁻ SO ₄ ²⁻ SO ₃ ²⁻ HS ⁻	hydrogen sulphate bisulphate thiosulphate HSO ₃ ⁻ SCN ⁻ S ₂ O ₃ ²⁻	perchlorate chlorite hypochlorite chromate dichromate cyanide hydroxide iodate nitrate nitrite	ClO ₄ ⁻ ClO ₂ ⁻ ClO ⁻ or OCl ⁻ CrO ₄ ²⁻ Cr ₂ O ₇ ²⁻ CN ⁻ OH ⁻ IO ₃ ⁻ NO ₃ ⁻ NO ₂ ⁻	oxalate permanganate phosphate hydrogen phosphate dihydrogen phosphate silicate sulphate sulphite hydrogen sulphide bisulphide	HSO ₄ ⁻ hydrogen sulphite bisulphite thiosulphate HSiO ₃ ⁻ SiO ₃ ²⁻ SO ₄ ²⁻ SO ₃ ²⁻ HS ⁻	hydrogen sulphate bisulphate thiosulphate HSO ₃ ⁻ SCN ⁻ S ₂ O ₃ ²⁻

atomic number
KEY: on charge (most common or most stable ion listed on top)

26	Fe ³⁺	iron(III)	symbol
26	Fe ²⁺	iron(II)	symbol
26	Fe ²⁺	ferrous	classical name
26	Fe ²⁺	stock (IUPAC)	name

Shaded area indicate this element does not form stable compounds

5	B	boron
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*Hg⁺ or Hg₂²⁺

TWO PLACE LOGARITHMS

NO.	LOG.	NO.	LOG.	NO.	LOG.	NO.	LOG.	NO.	LOG.
1.0	0.00	3.0	0.48	5.0	0.70	7.0	0.85	9.0	0.95
1.1	0.04	3.1	0.49	5.1	0.71	7.1	0.85	9.1	0.96
1.2	0.08	3.2	0.51	5.2	0.72	7.2	0.86	9.2	0.96
1.3	0.11	3.3	0.52	5.3	0.72	7.3	0.86	9.3	0.97
1.4	0.15	3.4	0.53	5.4	0.73	7.4	0.87	9.4	0.97
1.5	0.18	3.5	0.54	5.5	0.74	7.5	0.88	9.5	0.98
1.6	0.20	3.6	0.56	5.6	0.75	7.6	0.88	9.6	0.98
1.7	0.23	3.7	0.57	5.7	0.76	7.7	0.89	9.7	0.99
1.8	0.26	3.8	0.58	5.8	0.76	7.8	0.89	9.8	0.99
1.9	0.28	3.9	0.59	5.9	0.77	7.9	0.90	9.9	1.00
2.0	0.30	4.0	0.60	6.0	0.78	8.0	0.90	1.00	0.00
2.1	0.32	4.1	0.61	6.1	0.79	8.1	0.91	1.01	0.00
2.2	0.34	4.2	0.62	6.2	0.79	8.2	0.91	1.02	0.01
2.3	0.36	4.3	0.63	6.3	0.80	8.3	0.92	1.03	0.01
2.4	0.38	4.4	0.64	6.4	0.81	8.4	0.92	1.04	0.02
2.5	0.40	4.5	0.65	6.5	0.81	8.5	0.93	1.05	0.02
2.6	0.41	4.6	0.66	6.6	0.82	8.6	0.93	1.06	0.03
2.7	0.43	4.7	0.67	6.7	0.83	8.7	0.94	1.07	0.03
2.8	0.45	4.8	0.68	6.8	0.83	8.8	0.94	1.08	0.03
2.9	0.46	4.9	0.69	6.9	0.84	8.9	0.95	1.09	0.04

STANDARD ELECTRODE POTENTIALS

	Reduction Half-Reaction	E° (V)	
	$\text{F}_2(\text{g}) + 2\text{e}^- \longrightarrow 2\text{F}^-(\text{aq})$	+2.87	
	$\text{PbO}_2(\text{s}) + \text{SO}_4^{2-}(\text{aq}) + 4\text{H}^+(\text{aq}) + 2\text{e}^- \longrightarrow \text{PbSO}_4(\text{s}) + 2\text{H}_2\text{O}(\text{l})$	+1.68	
	$\text{MnO}_4^-(\text{aq}) + 8\text{H}^+(\text{aq}) + 5\text{e}^- \longrightarrow \text{Mn}^{2+}(\text{aq}) + 4\text{H}_2\text{O}(\text{l})$	+1.49	
	$\text{Au}^{3+}(\text{aq}) + 3\text{e}^- \longrightarrow \text{Au}(\text{s})$	+1.42	
	$\text{Cl}_2(\text{g}) + 2\text{e}^- \longrightarrow 2\text{Cl}^-(\text{aq})$	+1.36	
	$\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 14\text{H}^+(\text{aq}) + 6\text{e}^- \longrightarrow 2\text{Cr}^{3+}(\text{aq}) + 7\text{H}_2\text{O}(\text{l})$	+1.33	
	$\text{O}_2(\text{g}) + 4\text{H}^+(\text{aq}) + 4\text{e}^- \longrightarrow 2\text{H}_2\text{O}(\text{l})$	+1.23	
	$\text{MnO}_2(\text{s}) + 4\text{H}^+(\text{aq}) + 2\text{e}^- \longrightarrow \text{Mn}^{2+}(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$	+1.21	
	$\text{Br}_2(\text{l}) + 2\text{e}^- \longrightarrow 2\text{Br}^-(\text{aq})$	+1.07	
	$\text{AuCl}_4^-(\text{aq}) + 3\text{e}^- \longrightarrow \text{Au}(\text{s}) + 4\text{Cl}^-(\text{aq})$	+0.99	
	$\text{NO}_3^-(\text{aq}) + 4\text{H}^+(\text{aq}) + 3\text{e}^- \longrightarrow \text{NO}(\text{g}) + 2\text{H}_2\text{O}(\text{l})$	+0.96	
	$2\text{Hg}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Hg}_2^{2+}(\text{aq})$	+0.91	
	$\text{Hg}_2^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Hg}(\text{l})$	+0.85	
	$\frac{1}{2}\text{O}_2(\text{g}) + 2\text{H}^+(\text{aq})(1.0 \times 10^{-7} \frac{\text{mol}}{\text{L}}) + 2\text{e}^- \longrightarrow \text{H}_2\text{O}(\text{l})$	+0.82	
	$\text{NO}_3^-(\text{aq}) + 2\text{H}^+(\text{aq}) + \text{e}^- \longrightarrow \text{NO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$	+0.81	
	$\text{Ag}^+(\text{aq}) + \text{e}^- \longrightarrow \text{Ag}(\text{s})$	+0.80	
	$\text{Hg}_2^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow 2\text{Hg}(\text{l})$	+0.80	
	$\text{Fe}^{3+}(\text{aq}) + \text{e}^- \longrightarrow \text{Fe}^{2+}(\text{aq})$	+0.77	
	$\text{I}_2(\text{s}) + 2\text{e}^- \longrightarrow 2\text{I}^-(\text{aq})$	+0.54	
	$\text{O}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) + 4\text{e}^- \longrightarrow 4\text{OH}^-(\text{aq})$	+0.40	
	$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Cu}(\text{s})$	+0.34	
	$\text{SO}_4^{2-}(\text{aq}) + 4\text{H}^+(\text{aq}) + 2\text{e}^- \longrightarrow \text{H}_2\text{SO}_3(\text{aq}) + \text{H}_2\text{O}(\text{l})$	+0.20	
	$\text{Sn}^{4+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Sn}^{2+}(\text{aq})$	+0.15	
	$\frac{1}{8}\text{S}_8(\text{s}) + 2\text{H}^+(\text{aq}) + 2\text{e}^- \longrightarrow \text{H}_2\text{S}(\text{aq})$	+0.14	
	$\text{AgBr}(\text{s}) + \text{e}^- \longrightarrow \text{Ag}(\text{s}) + \text{Br}^-(\text{aq})$	+0.07	
	$2\text{H}^+(\text{aq}) + 2\text{e}^- \longrightarrow \text{H}_2(\text{g})$	0.00	
	$\text{Fe}^{3+}(\text{aq}) + 3\text{e}^- \longrightarrow \text{Fe}(\text{s})$	-0.04	
	$\text{Pb}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Pb}(\text{s})$	-0.13	
	$\text{Sn}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Sn}(\text{s})$	-0.14	
	$\text{AgI}(\text{s}) + \text{e}^- \longrightarrow \text{Ag}(\text{s}) + \text{I}^-(\text{aq})$	-0.15	
	$\text{Ni}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Ni}(\text{s})$	-0.23	
	$\text{Co}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Co}(\text{s})$	-0.28	
	$\text{PbSO}_4(\text{s}) + 2\text{e}^- \longrightarrow \text{Pb}(\text{s}) + \text{SO}_4^{2-}(\text{aq})$	-0.36	
	$\text{Cd}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Cd}(\text{s})$	-0.40	
	$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Fe}(\text{s})$	-0.41	
	$\text{Cr}^{3+}(\text{aq}) + \text{e}^- \longrightarrow \text{Cr}^{2+}(\text{aq})$	-0.41	
	$2\text{H}_2\text{O}(\text{l}) + 2\text{e}^- \longrightarrow 2\text{OH}^-(\text{aq})(1 \times 10^{-7} \frac{\text{mol}}{\text{L}}) + \text{H}_2(\text{g})$	-0.42	
	$\text{Cr}^{3+}(\text{aq}) + 3\text{e}^- \longrightarrow \text{Cr}(\text{s})$	-0.74	
	$\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Zn}(\text{s})$	-0.76	
	$2\text{H}_2\text{O}(\text{l}) + 2\text{e}^- \longrightarrow \text{H}_2(\text{g}) + 2\text{OH}^-(\text{aq})$	-0.83	
	$\text{SO}_4^{2-}(\text{aq}) + \text{H}_2\text{O}(\text{l}) + 2\text{e}^- \longrightarrow \text{SO}_3^{2-}(\text{aq}) + 2\text{OH}^-(\text{aq})$	-0.92	
	$\text{Al}^{3+}(\text{aq}) + 3\text{e}^- \longrightarrow \text{Al}(\text{s})$	-1.66	
	$\text{Mg}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Mg}(\text{s})$	-2.38	
	$\text{Na}^+(\text{aq}) + \text{e}^- \longrightarrow \text{Na}(\text{s})$	-2.71	
	$\text{Ca}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Ca}(\text{s})$	-2.76	
	$\text{Ba}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Ba}(\text{s})$	-2.90	
	$\text{K}^+(\text{aq}) + \text{e}^- \longrightarrow \text{K}(\text{s})$	-2.92	
	$\text{Li}^+(\text{aq}) + \text{e}^- \longrightarrow \text{Li}(\text{s})$	-3.05	

Note: Unless otherwise indicated

- all ions in this table are in aqueous solution
- all concentrations are 1.0 mol/L and all gases are at 101 kPa pressure
- E° values have been measured at 298 K (25°C)

SOLUBILITY OF SOME IONIC COMPOUNDS IN WATER AT 298 K (25°C)

ION	Group IA		NH ₄ ⁺	NO ₃ ⁻	CH ₃ COO ⁻	Cl ⁻ Br ⁻ I ⁻	SO ₄ ²⁻	S ²⁻	OH ⁻	PO ₄ ³⁻
	alkali metal ions	H ⁺ (H ₃ O ⁺)								SO ₃ ²⁻ CO ₃ ²⁻
SOLUBILITY OF >0.1 mol/L (VERY SOLUBLE)	All	All	All	All	Most	Most	Most	Group IA Group IIA NH ₄ ⁺	Group IA NH ₄ ⁺ Sr ²⁺ Ba ²⁺ Tl ⁺	Group IA NH ₄ ⁺
SOLUBILITY OF <0.1 mol/L (SLIGHTLY SOLUBLE)	None	None	None	None	Ag ⁺	Ag ⁺ Pb ²⁺ Hg ₂ ²⁺ Cu ⁺ Tl ⁺	Ca ²⁺ Sr ²⁺ Ba ²⁺ Ra ²⁺ Ag ⁺ Pb ²⁺	Most	Most	Most

NLC-B.N.C.



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